

# UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING SOLID BODIES FROM POWDER OR OTHER LOOSE MATERIAL.

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Specification of Letters Patent.

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*To all whom it may concern:*

Be it known that I, JOSEPH A. WILLIAMS, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Methods of Producing Solid Bodies from Powder or other Loose Material, of which the following is a full, clear, and exact description.

This invention relates to certain improvements in the process of producing solid bodies wherein finely divided material or material in the form of powder is compressed into a bar, brick or ingot, and has for its object the production of a denser metal or other body.

The invention may be utilized with a variety of different materials and in numerous arts, but has particular utility in the production of solid metal tungsten and other rare materials which have very high fusion temperatures and which are formed by swaging bricks or ingots previously formed by compressing material in powdered form.

In the following description my invention is described as applied to the art of producing tungsten, although it may be employed with other metals or materials.

In the production of what I term solid metal tungsten, such as tungsten wire for use as lamp filaments and for other purposes, tungsten in the form of powder or loose crystals is compressed generally by means of a hydraulic press into a brick or ingot which for convenience will be termed a bar. This bar is then heated in an atmosphere of hydrogen to partly sinter it. Then the bar is placed in a so-called treating bottle and heavy current is passed through it in the presence of hydrogen, this being continued until the bar is heated almost to a molten state. In this step of the process the bar shrinks very perceptibly in volume. Then the bar is reduced to the form of rod or wire by repeatedly swaging and heating. The rod or wire thus formed is ductile and is used for numerous purposes, but is generally drawn through diamond dies to form fine wire lamp filaments.

I have found that the density of the finished product, and certain other characteristics or properties are affected or limited by the density of the bar which is produced by subjecting the powdered tungsten to pressure. Heretofore the powdered tungsten could be compressed only to a certain density, and this is due to the fact that it has

been found unfeasible to employ tungsten powder having more than a certain degree of fineness, and also to the fact that the pressure to which the powder could be subjected in forming a brick or ingot is limited. If the powder is subjected to more than a predetermined pressure in the press, the brick will split or cleave and is thereby rendered useless.

By my invention I am enabled to use a finer powder, and am also able to subject the powder to greater pressure than was heretofore possible. By way of explanation it may be stated that I have found that with the process carried on heretofore a finer powder and also a greater pressure could not be employed successfully because of the presence of air in the mass of powder between the particles or crystals composing the bar. I have not been able to ascertain definitely why this is true, but I believe that the fine grains of powder, *i. e.*, the powder finer than that heretofore employed successfully, could not be employed because the air can not readily escape while the powder is being compressed to form the bar, and I believe also that the cleaving of the bar when excessive pressure is employed is due also to the presence of air,—possibly the expansion of air when the pressure is removed.

In carrying out my invention I remove air from the powder or from the bar being compressed and am thereby enabled to employ finer powder and greater pressure than heretofore, and preferably this is accomplished by compressing the powder in a vacuum or partial vacuum which for convenience will be termed "*in vacuo*", *i. e.*, in a chamber from which as much of the air is removed as is practically possible.

Although the step of the process can be carried out in numerous different ways, and with many different kinds of apparatus, in the accompanying sheet of drawings I have shown one way of accomplishing the result. and in the drawings Figure 1 is a side view of a hydraulic press equipped with an attachment by which the powder or finely divided material can be compressed in a vacuum; and Fig. 2 is a horizontally sectional view substantially along the line 2—2 of Fig. 1.

The device shown in the drawings consists of a hydraulic press, including an upper stationary head 10, a vertically movable table or plunger 11 having a piston ex-